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IMPLEMENTATION AND ANALYSIS OF OFDM BASED IEEE 802.11G VANET

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ABSTRACT

Vehicular Ad hoc Network (VANET), a rapidly deployed wireless network, that uses multi-hop routing to provide network connectivity among vehicles. The interconnections between the vehicles vary rapidly, due to their frequent movements in the VANET, resulting in frequent variation of network topology and consequently, introduce route failures in such networks. Also, the issue of mobility-induced route failures needs to prevail over significantly in VANETs to provide effective network access to vehicles without any distraction of services in conjunction with optimum QoS. This paper evaluates the impact of mobility speed over varying number of mobile nodes roaming randomly, over the performance of different ad hoc routing protocols in OFDM based IEEE 802.11g VANET at high data rate of 54Mbps, not reported in previous work. This work is demonstrated by DCF-MAC protocol implementation under VoIP traffic load by means of OPNET Modeler 14.5.

KEYWORDS: Vehicular Ad hoc Network (VANET), DCF-MAC Protocol Implementation, OPNET Modeler 14.5

INTRODUCTION

In Modern Wireless Communication Systems, a user can move around while maintaining connectivity with the rest of world using Mobile Ad hoc networking (MANET) and has grown extensively in the last two decades [1-2]. Intelligent transportation system (ITS) has been designed to improve safety and efficiency of transportation system and to enable new mobile application and service for passenger [3-4]. The inter-vehicle communication consists of both Vehicle-to-vehicle (V2V) and vehicle-to-roadside communication (V2R) known as VANET. All network activities such as discovering of network topology and delivering of messages is carried out by the nodes themselves in such networks. Nodes in VANET utilize the same random access wireless channel, cooperating in an intimate manner to engaging themselves in multi-hop forwarding [5]. Due to frequent variations in mobility of nodes in terms of speed, direction and rate, the structure of the network varies dynamically and unpredictably over time and causes route failures. Mobility-induced path failure, which affects packet loss rates, end-to-end delay, throughput and packet delivery fraction/ratio, is a key obstacle to improving QoS in ad hoc networks. Also, it is a challenging task in MANETs to choose effective route to establish the connection between a source and a destination to realize a robust communication even when they are roaming around at high speeds. To analyze the performance of VANET networks over different routing protocols over it is essential to analyze the movement pattern of mobile nodes at varying network sizes. In wireless networks, the widely used mobility model is random waypoint due to its simplicity to implement in the simulation environment for various analyses [6]. Due to the limited bandwidth available through mobile radio interfaces, it is essential that the amount of control traffic, generated by the routing protocols is kept at a minimum [7]. In the past few years, a lot of research has been done on ad hoc routing to provide adequate performance; accordingly can be classified into proactive- , reactive-, hybrid- and

Geographical routing protocols. Proactive routing (OLSR) continuously makes routing decisions so that routes are immediately available when packets need to be transmitted. Reactive routing (AODV, DSR) determines routes on an as-needed basis: when a node has a packet to transmit, it queries the network for a routing. In Geographical routing protocols (GRP), each node can determine its location as well as destination location. With this information, a message can be sent to the destination without knowing the network topology or the discovery of the route [8]. In this paper, VANET ad hoc networks with reactive-, Hybrid- and Geographical- ad hoc routing protocols are studied and evaluated using OPNET Modeler 14.5 and MATLAB. Then performance comparison has been performed between various ad hoc protocols (AODV, DSR, OLSR and GRP) for various routing parameters and QoS in MANET for GSM quality voice traffics.

AD HOC ROUTING PROTOCOLS BACKGROUND

AODV builds routes using a route request / route reply query cycle. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables. A node receiving the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the RREQ. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it of the now unreachable destination(s). After receiving the RERR, if the source node still desires the route, it can reinitiate route discovery [9-11]. DSR is a reactive protocol i.e. it doesn't use periodic advertisements. There are two significant stages in working of DSR: Route Discovery and Route Maintenance. A host initiating a route discovery broadcasts a route request packet which may be received by those hosts within wireless transmission range of it. The route request packet identifies the host, referred to as the target of the route discovery, for which the route is requested. If the route discovery is successful the initiating host receives a route reply packet listing a sequence of network hops through which it may reach the target. In DSR, as the route is part of the packet itself, routing loops, either short-lived or long-lived, cannot be formed as they can be immediately detected and eliminated [12-14]. OLSR protocol is a proactive link state routing protocol which reduces the control overhead by reducing the number of broadcasts as compared with pure blind 'flooding' mechanisms. The basic concept of OLSR is the use of multipoint relays (MPRS). MPRS refer to the selected routers that can forward broadcast messages during the flooding process. To reduce the size of broadcast messages every router declares only a small subset of all of its neighbors. OLSR has three functions: packet forwarding, neighbor sensing, and topology discovery. Packet forwarding and neighbor sensing mechanisms provide routers with information about the neighbors and offer an optimized way to flood messages in the OLSR network using MPRS. The neighbor sensing operation allows routers to diffuse local information in the whole network. Topology discovery is used to determine the topology of the entire network and to construct the routing tables [15-16].Geographic Routing Protocol (GRP) is a position-based protocol classified as Proactive Routing Protocol. Each location of the node will be marked by Global Positioning System (GPS) and the flooding will be optimized by quadrants. Flooding location is updated on the distance when a node moves and crosses a neighborhood. A 'Hello' message will be exchanged among nodes to identify their neighbors and their positions. By using route locking a node can return its packet to the last node when it cannot keep on sending the packet to the next node. GRP divides an ad hoc network into many quadrants to reduce route flooding. Every node knows the initial position of every other accessible node once initial 'flooding' is completed in the network. When the node moves a distance that is longer than the user has specified or when the node crosses a quadrant the routing flooding will take place [17-18].

SIMULATION SETUP

Using OPNET 14.5 simulator, we have designed and investigated different VANET scenarios with network size of 1000*1000 m^2 with different number of mobile nodes of [60, 80] using uniform mobility speed of 40 to 60 km/hr and 60 to 80 km/hr respectively. The work is demonstrated using high network traffic load i.e. with VoIP applications for simulation interval of 5 minutes as shown in Figure 2 at high data rate of 4 Mbps using IEEE 802.11g physical characteristic. Mobility model used is Random Waypoint Model with mobility of 500*500 meter [19]. The performance of the VANET network is evaluated by implementing the AODV, DSR, OLSR, GRP routing protocol under the impact of different mobility speeds in different scenarios. The lower 2 layers parameters are common to all mobility scenarios as shown in Table 1 [20]. The traffic flows randomly between different workstations placed at different distances in different scenarios as shown in Figure 1.

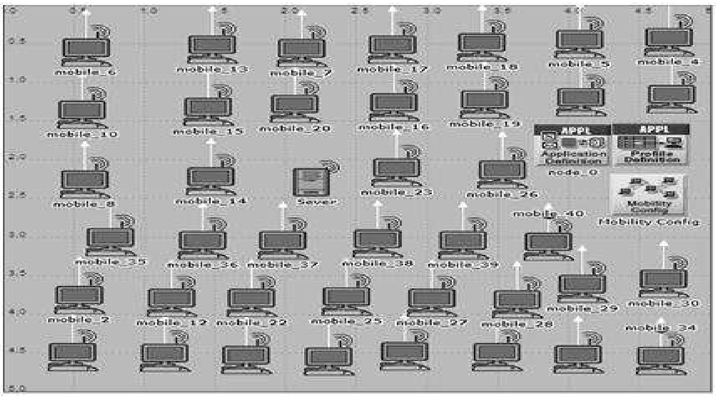

Figure 1: Model of OFDM based IEEE 802.11g VANET Network

Table 1: Simulation Parameters

Radio interface	OFDM
Data Rates	54 Mbps
Transmit Power	0.005mW
RTS Threshold	256
Packet- Reception Threshold	-95
Long Retry Limit	4
Max Receive Lifetime (sec.)	0.5
Buffer Size(bits)	102400000

RESULTS & DISCUSSIONS

To evaluate the performance of various route information based protocols in IEEE 802.11g VANET under the impact of mobility speeds of [40-60 km/hr and 60-80 km/hr] for 60 and 80 nodes respectively at high data rate of 54 Mbps, we have determined the various QoS parameters such as Throughput, End-to-End Delay, Packet Delivery Ratio and Normalized Routing Load. The Figure 2 shows a comparison for throughput, the loss rate as seen by the transport layer and reflects the completeness and accuracy of the routing protocol, as a function of mobility speed at different network sizes. From 2(a) graph, it is clear that OLSR enabled 60 nodes at mobility speed of [40-60] km/hr has highest throughput and that

throughput increases sharply with simulation time, average throughput for AODV is nearly 6248.449 Kbps, where average throughput for GRP during simulation period is nearly 1851.898 Kbps. Alternatively, a drop in throughput is reported in case of reactive routing protocols that are DSR (1245.225 kbps) and AODV (1072.183 kbps) with respect to simulation time. OLSR and GRP perform better due to the fact that all routes are computed at no extra cost, while Reactive routing protocols (AODV & DSR) must initiate several route discovery processes [21].

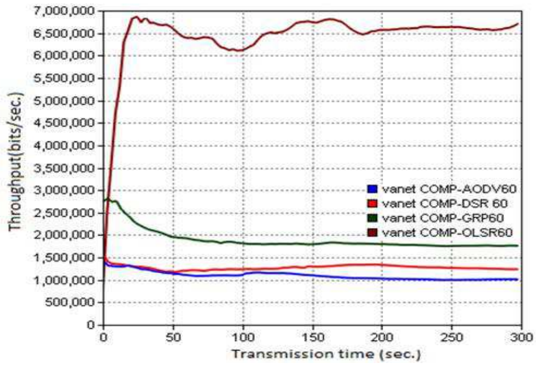

Figure 2(a): Throughput Comparison of 60 Nodes VANET Network using Different Ad hoc Routing Protocols

Further, it is also observed that with increase in network size (80 nodes) and mobility speed (60-80 km/hr.), AODV and DSR enabled VANET network starts performing better i.e. 1106.188 kbps and 1755.927 kbps respectively, while performance of OLSR network degraded from 6248.449 Kbps to 4769.826 kbps in highly stressed networks as shown in figure 2 (b) and table-2. Figure 3 calculates the average packet end-to-end delay of each transmitted packet during the simulation period and includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at MAC, propagation- and transfer- time [22]. From the graph 3(a), it is observed that average end-to-end delay for 60 mobile nodes is minimum for OLSR and GRP routing protocols (nearly 1.133 & 1.336 sec. respectively) as compare to AODV (nearly 2.787 sec.), where for DSR that delay further increases to high value of 13.12 seconds. High delays in reactive protocols is due to reason that Reactive protocols (DSR and AODV) drop a considerable number of packets during the route discovery phase, as route acquisition takes time proportional to the distance between the source and destination [23]. Poor performance of DSR is due to the fact that in case of congestion or high traffic, control messages get loss and thus, eliminating its advantage of fast establishing new route with DSR routing scheme [24]. With the increase in the number of source nodes to 80 and mobility speed to uni[60-80], these delays increase sharply throughout the simulation period for AODV, DSR and OLSR, which is almost three times for AODV and five time more in case of OLSR, where for GRP end-to-end delay almost remains with increase in nodes as well as their mobility speed same as shown in figure 3(b).Increase in delays for different routing protocols is due to the increase in congestion in the network with the increase in number of nodes and mobility speed. GRP delays are lowest and remain almost constant with change in network size & mobility speed because GRP divides an ad hoc network into many quadrants to reduce route flooding and when the node moves a distance that is longer than the user has specified or when the node crosses a quadrant the routing flooding will take place [17]. Figure 4 shows the calculation of packet delivery ratio/fraction (PDR), defined as the ratio between the number of packets originated by the application layer CBR sources and the Number of packets received by the CBR sink at the final destination, at different speeds and source nodes [25].

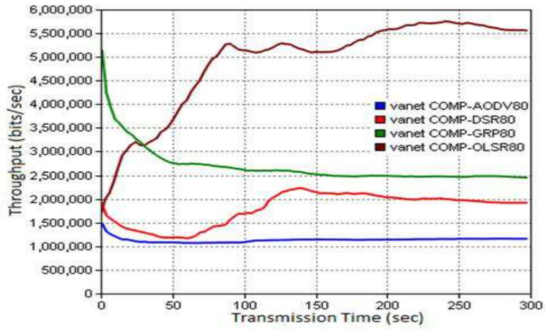

Figure 2(b): Throughput Comparison of 80 Nodes VANET Network using Different Ad hoc Routing Protocols

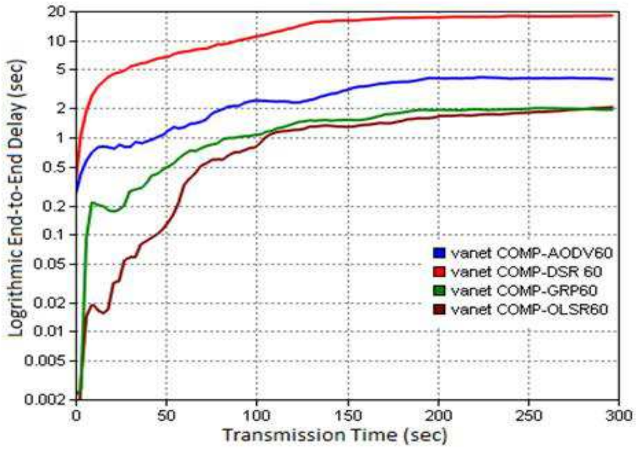

Figure 3(a): End-to-End Delay Comparison of 60 Nodes VANET Network using Different Ad hoc Routing Protocols

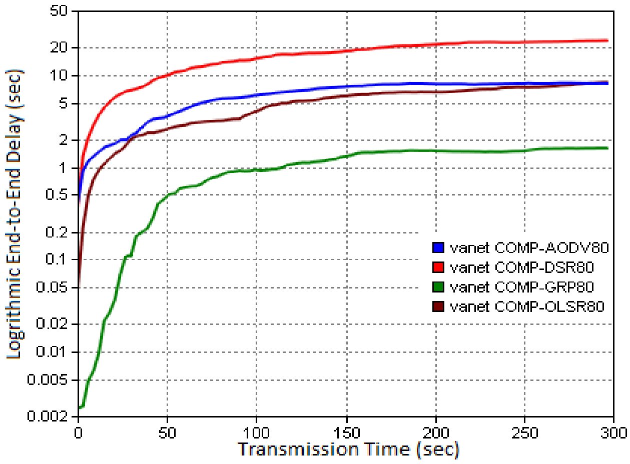

Figure 3(b): End-to-End Delay Comparison of 80 Nodes VANET Network using Different Ad hoc RoutingProtocols

The PDR decreases with increase in mobile nodes (from 60 to 80 nodes) and mobility speed for all reactive routing protocols as shown in graph 4, because the increase in number of nodes causes the collision during packet delivery. It is observed from graph, OLSR ad hoc routing protocol PDR performance is best for 60 node network (i.e. 0.752) but as the network size and mobility speed is increased to 80 and uni [60-80 km/hr] respectively, PDR performance of OLSR

drops to 0.437 and AODV starts performing better under these stressful situations having best PDR of 0.549 than other proactive protocols.

The reason of poor PDR performance at large scale networks with increased mobility speed, as they need to maintain node entries for each and every node in the routing table of every node. This causes more overhead in the routing table leading to consumption of more bandwidth [26].

The PDR performance of DSR routing protocol is worse as comparison with other ad hoc routing protocols and becomes worst with increase in network scale as shown in graph 4, due to its high delays as shown in figure 3. Reactive routing protocol AODV perform better than other protocols, because AODV packets contain the destination address and AODV route replies need only carry the destination IP address and sequence number, as opposed to only next hop information in AODV [27].

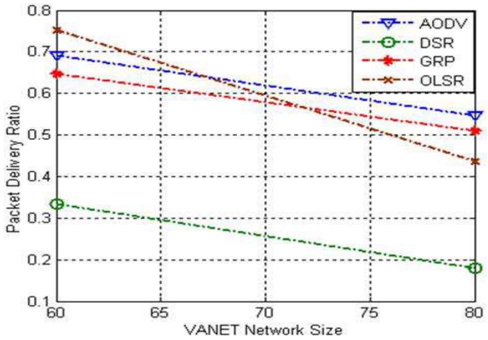

Figure 4: Packet Delivery Ratio of Different VANET Nodes using Different Ad hoc Routing Protocols

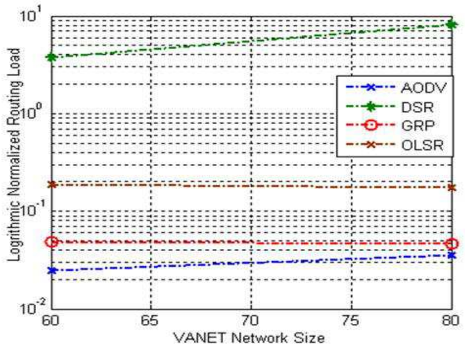

Figure 5: Normalized Routing Load of Different VANET Nodes using Different Ad hoc Routing Protocols

Figure 5 shows the calculation of normalized routing load of different route information based protocols at different speeds and source nodes. It is observed that for AODV showed lowest normalized routing load at all the speed levels and network sizes nearly 0.0245 and 0.035 respectively. Normalized routing load of AODV is better as compare to proactive routing protocols (OLSR & GRP), where in case DSR routing load is worst and further increased highly with increase in network size and mobility speed. The measured values of QoS matrices, used in our work, as a function of nodes and node-mobility is given in tabular form in Table 2 and 3.

Table 2: Average Throughput & End-to-End Delay Comparison at Different Ad hoc Routing Protocols

Routing Protocol	Avg. Throughput (kbps)		End-to-End Delay (sec.)	
	60- Nodes	80- Nodes	60- Nodes	80- Nodes
AODV	1072.183	1106.188	2.78777	6.280319
DSR	1245.225	1755.927	13.12408	16.70265
GRP	1851.898	2626.499	1.336746	1.074374
OLSR	6248.449	4769.826	1.132618	5.120283

Table 3: Packet Delivery Ratio & Normalized Routing Load Comparison at Different Ad hoc Routing Protocols

Routing Protocol	Packet Delivery Ratio		Normalized Routing Load	
	60- Nodes	80- Nodes	60- Nodes	80- Nodes
AODV	0.691716	0.547691	0.024533	0.03564
DSR	0.333768	0.179045	3.761892	8.125659
GRP	0.646697	0.50891	0.04878	0.046682
OLSR	0.752834	0.437099	0.18674	0.174536

CONCLUSIONS

This work emphasized on a simulation model based performance comparison of different route information ad hoc routing protocols based IEEE 802.11g VANET at high data rate of 54 Mbps using OFDM radio network interfaces and DCF-MAC protocol implementation to demonstrate the impact of different number of nodes as well as mobility speed of these nodes. The general observation from the simulation is that proactive protocols (OLSR & GRP) outperforms in less “stressful” situations i.e. smaller number of nodes with low mobility speed (uni[40-60]), but as number of nodes and mobility speed further increased, proactive protocols performance degrades highly, where AODV shows better performance in terms of throughput and end-to-end delay in stressful situations. AODV outperform all protocols in terms of routing oriented matrices such as packet delivery ratio and normalized routing load for moderate as well as stressful situations. DSR has very poor QoS in high populated node networks with VoIP data traffic.

REFERENCES

1. D. Chalmers and M. Sloman, “A survey of quality of service in mobile computing environments,” IEEE Communications Surveys and Tutorials, vol. 2, No. 2, pp. 2-10, 1999.

2. S. Corson. and J. Macker. “Mobile Ad Hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Consideration”, available at http://www.ietf.org/rfc/rfc2501.txt.

3. Sherali Zeadally, Ray Hunt, Yuh-Shyan Chen, Angela Irwin, Aamir Hassan, “Vehicular Ad hoc network (VANET): status, Results and Challenges,” springer science, business media, LLC 2010, Telecommunication syst. DOI 10.1007/s11235-010-9400-5.

4. Toh K., “Ad Hoc mobile wireless networks: protocols and systems,” 1st edition. New Jersey (USA): Prentice Hall, ISBN 0-13-007817-4, 2002.

5. Feeney L.M., “A Taxonomy for Routing Protocols in Mobile Ad hoc Networks,” Technical Report, Swedish Institute of Computer Science, Sweden, 1999.

6. Camp T., Boleng J., Davies V. “A Survey of Mobility Models for Ad Hoc Network Research,” Wireless Communication & Mobile Computing (WCMC): vol. 2, no. 5, pp. 483-502, 2002.

7. Elizabeth M., Toh C., “A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks”, pp. 1-22, Ad Hoc Networks 2, 2004.

8. Kamini, Rakesh Kumar, “VANET Parameters and application: A Review”, Proceedings of Global Journal of Computer Science and Technology, vol.10, Issue 7, ver.1.0, pp.72-77, 2010.

9. Abolhasan M., Wysocki, T., Dutkiewic E., “A Review of Routing Protocols for Mobile Ad -Hoc Networks,” ELSEVIER, Adhoc Networks 2 (2004), pp. 1-24, 2004.

10. Perkins C. E. and Royer E. M., “Ad hoc On Demand Distance Vector Routing,” Proc. in 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA), New Orleans, LA, pp. 90-100, 1999.

11. Perkins C., Royer E. B. and Das S., “Ad hoc On-Demand Distance Vector (AODV) Routing - Internet Draft,” IETF Network Working Group, RFC 3561, pp.1-38, 2003.

12. Johnson D. B., Maltz D. A. and Hu Y. C., “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR),” Internet-draft, 2004, available at http://www.ietf.org/internet-drafts/draft-ietf-manet-dsr-10.txt.

13. Johnson D. B., Maltz D. A., Hu Y.C., “The Dynamic Source Routing Protocol for Mobile Adhoc Networks (DSR),” IETF Draft, work in progress, 2003, available at http://www.ietf.org/internet-drafts/draft-ietf-manet-dsr-09.txt.

14. Almutairi A.F. and El-Hendawy T.M., “Performance investigation using different software of Dynamic Source Routing in ad hoc networks,” Proc. in GCC Conference -& Exhibition GCC’11, pp. 307-310, 2011.

15. T. Clausen, and P. Jacquet, “Optimized Link State Routing Protocol (OLSR),” IETF, RFC 3626, 2003.

16. H. Badis, and K. Al Agha, “QOLSR, QoS routing for Ad Hoc Wireless Networks Using OLSR,” in European Transactions on Telecommunications, vol. 16, No. 5, pp. 427-442, 2005.

17. Jain, R., Puri, A. and Sengupta, R., “Geographical Routing Using Partial Information for Wireless Ad Hoc Networks,” IEEE Personal Communications Magazine, Vol. 8, No. 1, pp. 48–57, 2001.

18. M. Mauve, J. Widmer, H. Hartenstein, “A Survey on Position-based Routing in Mobile Ad hoc Networks,” IEEE Network Magazine, vol. 15, No. 6, pp. 30-39, 2001.

19. P. Johansson et al., “Routing Protocols for Mobile Ad hoc Networks- A Comparative Performance Analysis,” Proc. IEEE/ACM MOBICOM ’99, pp. 195–206, 1999.

20. MANET, Operation Manual for OPNET, 2007.

21. Haerri, J., Filali, F., Bonnet, C., “Performance Comparison of AODV and OLSR in VANETs Urban Environments under Realistic Mobility Patterns,” Proc. of 5th Annual Mediterranean Ad Hoc Networking Workshop, 2006.

22. Perkins C., Royer E., Das R. , "Performance Comparison of Two On-Demand Routing Protocols for Ad Hoc Networks," pp. 16- 28, IEEE Personal Communications, 2001.

23. Samir R. Das, Robert Castaneda and Jiangtao Yan, "Simulation based performance evaluation of routing protocols for mobile ad hoc networks," Journal Mobile Networks and Applications, vol. 5 Issue 3, Sept. 2000.

24. Anders, L., Andreas, A. and Olov, S. (2003), "Quality of Service Schemes for IEEE 802.11 Wireless LAN- An Evaluation," Mobile Networks and Applications, vol. 8, pp. 223-235, 2003.

25. Wang L., Shu Y., Dong M., Zhang L., Yang W., "Adaptive Multipath Source Routing in Ad Hoc Networks," IEEE International Conference on Communications, ICC-2001, 2001.

26. Anwar, F., Naeem, J., Abedin, M.S.M., "A simulation based performance comparison of routing protocol on Mobile Ad hoc Network (proactive, reactive and hybrid)," IEEE International Conference on Computer and Communication Engineering (ICCCE), pp 1-5, 2010.

27. Taneja, S., Kush, A. , "A Survey of Routing Protocols in Mobile Ad hoc Networks," International Journal of Innovation, Management and Technology, vol. 1, No. 3, pp. 279-285, 2010.